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The PLANET microlensing campaign: Implications for planets around galactic disk and bulge stars

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Abstract. With round-the-clock monitoring of galactic bulge microlensing events, the PLANET experiment constrains the abundance and can yield the discovery of planets down to the mass of earth around galactic disk and bulge stars. Data taken until 1999 imply that less than 1/3 of bulge M-dwarfs are surrounded by jupiter-mass companions at orbital radii between 1 and 4 AU. The current rate of microlensing alerts allows 15–25 jupiters and 1–3 earths to be probed per year.

Microlensing is sensitive to unseen planets of mass m at a projected orbital radius r_p around unseen lens stars of mass M, mainly M-dwarfs ($M \sim 0.3\ M_\odot$), at the distance D_L that cause microlensing events of durations $\sim$ 1 month on background source stars at the distance D_S. Distortions of 1–20 % to the microlensing light curve caused by a planet last from hours (earth) to days (jupiter) and their probability increases towards $r_\mathrm{p} \sim r_\mathrm{E} \sim 2.5$ AU, where

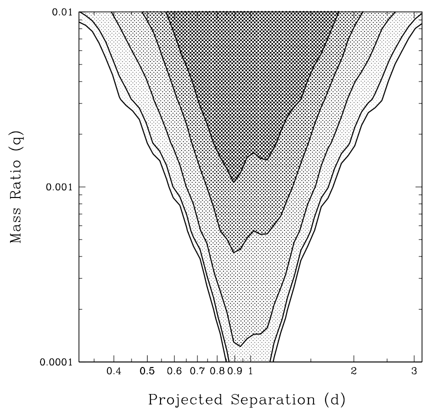

Figure 1. Fractions $f(d,q) =$ 3/4, 2/3, 1/2, 1/3, and 1/4 (inside to outside) of lens stars surrounded by a companion with mass ratio $q = m/M$ at $d = r_\mathrm{p}/r_\mathrm{E}$ that are excluded at 95 % C.L.

$r_\mathrm{E} = \sqrt{2\,R_\mathrm{S}\,D}$ denotes the Einstein radius of the lens star, with $R_\mathrm{S} = (2GM)/c^2$ being the Schwarzschild radius and $D = D_\mathrm{L}\,(D_\mathrm{S} - D_\mathrm{L})/D_\mathrm{S}$.

With generous time allocations at the observatories, PLANET (Probing Lensing Anomalies NETwork) obtained a dense round-the-clock coverage of galactic bulge microlensing events in I with additional observations in R and V with its current network of 1m-class telescopes formed by SAAO 1.0m (South Africa), Danish 1.54m at ESO LaSilla (Chile), Canopus 1.0m (Tasmania), and Perth 0.6m (Western Australia), and also with Dutch 0.9m and 2.2m at ESO La Silla, 0.9m and Yale 1.0m at CTIO (Chile), and MSO 50" (Australia).

The photometric precision of 1–2 %, dictating the exposure time with the target brightness, and a sampling interval of 1.5–2.5 hrs, allowing a *characterization* of distortions by jupiters, limit the number of events monitored to up to 20 events at the same time or 75 events per season (Dominik et al. 2002).

The target monitored at any given time is selected with the aim to maximize the planet detection efficiency. Events with large peak magnification A_0 are preferred but spending the whole observing time on such events is not optimal for obtaining results on the abundance of jupiters (Horne 2003), whereas all the information about earths will arise from events with $A_0 \gtrsim 80$ only.

Currently, OGLE-III provides ~ 500 and MOA provides ~ 60 microlensing alerts per year, which will allow PLANET to probe 15–25 jupiters and 1–3 earths per year. If no planetary distortions are observed, the abundance limits from three years of observations will be 4–7 % for jupiters and ~ 40 % for earths.

The figure shows the limits on the abundance of planets resulting from monitoring 42 events by PLANET between 1995 and 1999 (Gaudi et al. 2002).

References

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